EVALUATION OF TEXTURE AND COLORIMETRIC PROPERTIES OF IRRADIATED ICE CREAM

Vladimir D. Rogovschi[1], Thaise C. F. Nunes[1], Juliana M. A. Sagretti[1], Adriana D. T. Fabbri1, Susy F. Sabato[1]

[1] Instituto de Pesquisas Energéticas e Nucleares (IPEN / CNEN - SP)
Av. Professor Lineu Prestes 2242
05508-000 São Paulo, SP
vladrogo@yahoo.com.br

ABSTRACT

The ice cream consists of an aerated suspension of fat and crystals in a concentrate sugar solution where other ingredients may be added provided that does not mischaracterize the product. It is one of the most important product of the dairy industry. The ice cream is considered a high nutritional value food providing fat, carbohydrates, proteins, vitamins and mineral to its consumers. The aim of this study was to evaluate the effects of the gamma radiation process in the color and texture of milk based ice cream purchased at São Paulo retail market, Brazil. The samples were irradiated with doses of 1.0 and 2.0 kGy into isothermal boxes at ^{60}Co Multipurpose Irradiator (IPEN-CNEN/SP) at -72 °C and it was immediately stored at -10 °C until the moment of the analyses. The color parameter were $L*$, $a*$ and $b*$ using a CR-400 Minolta Colorimeter and the texture was analyzed using a Stable Micro Systems texture analyzer (model TA-TX Plus) equipped with a Multiple Puncture Probe. It was observed that the control and irradiated sample differs statistically for the texture analysis. In the color analysis it was observed that the $L*$ parameter have increased less than 5.0 % between the control and 2.0 kGy sample. For the parameters $a*$ and $b*$ the value rose by 18 % and 2.31 %, respectively. The authors concluded that even with the statistical difference the gamma radiation can be applied in ice creams.

1. INTRODUCTION

The milk based ice cream consists of an aerated suspension of fat and ice crystals in a concentrated sugar solution containing hydrocolloids, fats and proteins, and its composition may vary from one region to another [1,2]. Fats can vary from 8 to 20 %, the non-fat solids of the milk range from 8 to 15 % and sugar ranges from 13 to 20 %. According to Brazilian Regulation RDC 266/05, ice cream is a frozen product obtained from the emulsion of fat and protein or a mixture of water and sugar, other ingredients may be added since do not mischaracterize the product [3].

The ice cream is considered a food of high nutritional value, providing lipids, carbohydrates, protein, calcium, phosphorus, minerals and vitamins A, B1, B2, B6, C, D, E and K [4,5]. It is the most important and of greater interest to the dairy industry due to high demand by the population [6,7]. According to the Brazilian Association of Ice Cream in the year 2009 were produced 998 million gallons of ice cream, with 718 million for the creamy ice cream, placing Brazil in 10th place ranking in worldwide producer of ice cream and 11th in the consumer [8].

Ice cream is a great medium for microbial growth, due to long time of storage and pH near neutrality [9]. The contamination of ice cream by microbial pathogens resulted in several outbreaks in North America, Asia and Europe [10].

Gamma radiation is an effective tool due to the fact that it can be easily applied in products such as ice cream, which must be stored at low temperatures and cannot be treated with methods, such as heating [11,12]. The objective of this work was to analyze the texture and colorimetric properties of irradiated creamy ice cream.

2. MATERIAL AND METHODS

2.1. Sample

Samples of low fat creamy ice cream were purchased in the São Paulo retail market.

2.2. Irradiation

The ice cream samples were irradiated in the ^{60}Co Multpurpose Irradiator from IPEN/CNEN-SP (Brazil) with 1.0 kGy and 2.0 kGy at -72 °C. Gammachrome YR Batch 5 (530 nm) dosimeters were used to measure gamma radiation absorption.

2.3. Colorimetric Analysis

The color analysis was determined by reflectance with handheld colorimeter (Minolta Chroma-meter model CR400 Minolta Camera Co., Japan). The parameters analyzed were $L*$ (lightness), $a*$ (grade of greenness/redness) and $b*$ (grade of blueness/yellowness) [13].

2.4. Texture Analysis

The ice cream texture was analyzed using a Stable Micro Systems texture analyzer (model TA-TX Plus) equipped with a Multiple Puncture Probe at 10 °C [14].

2.5. Statistical Analysis

The statistical analysis was conducted with One-Way ANOVA and Tukey's Test ($p < 0.05$) using the GraphPad Prism 5 software.

3. RESULTS AND DISCUSSION

3.1. Colorimetric Analysis

The colorimetric analyze was conducted using the parameters $L*$, $a*$ and $b*$ (Fig. 1). The results of parameter $L*$ showed that the control sample and the 1.0 kGy sample do not differ significantly, however this difference could be observed among the 0 kGy and 2.0 kGy samples and 1.0 kGy and 2.0 kGy samples. For parameter $a*$ no statistical difference was observed among the samples, excepted between the control and 2.0 kGy samples. The results of the parameter $b*$ showed significant difference only between the 0 kGy sample and 1.0 kGy sample. Although some fluctuation was observed, averages of each result from samples

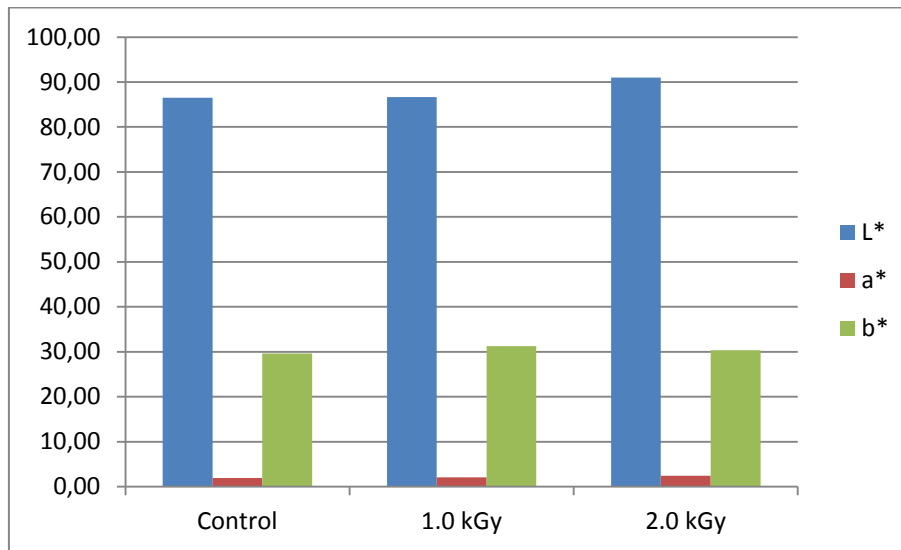treated with different doses were homogeneous.

Figure 1: Colorimetric results.

3.2. Texture Analysis

It can be observed that the 1.0 kGy and 2.0 kGy samples did not show significant difference, although the irradiated samples showed statistical difference from the control group (Table 1).

Table 1: Texture results of low fat ice cream.

Sample	Texture (N)		
	0 kGy	1.0 kGy	2.0 kGy
	36.64	20.68	23.68
	48.54	27.52	24.67
Low fat ice cream	43.29	20.37	22.71
	31.22	14.09	19.54
	49.53	18.72	25.90
	31.77	15.44	18.24
Average	40.17 [a]	19.47 [b]	22.46 [b]
SD*	8.1	4.7	3.0

* Standard Deviation

Oliveira (2005) [15] showed a texture value of 24.04 N and 34.38 N for low fat creamy ice cream, respectively, which means that the low fat ice cream is harder comparing to a regular one because the fat improve the texture of the product, making it more smooth [16]. In the present work the texture values found were 40.17 N for the control group, 19.47 N for the 1.0 kGy samples and 22.46 N for the 2.0 kGy samples. Although, Aime et al. (2001) [17]

presented values of 90.8 N for regular ice cream and 80.8 N for low fat ice cream. It was not found papers related to instrumental texture analysis of irradiated ice cream to be compared with this work.

4. CONCLUSION

It could be conclude that the low fat creamy ice cream with 1.0 kGy showed minimum difference in relation to non-irradiated one for colorimetric and texture parameters, demonstrating the use of radiation treatment to this food.

ACKNOWLEDGMENTS

REFERENCES

1. K. H. Oliveira, J. A. R. Souza, A. R. Monteiro, "Caracterização reológica de sorvetes" *Ciência e Tecnologia de Alimentos*, **28**, pp. 592-598 (2008).
2. W. S. Arbuckle, *Ice Cream*, AVI Publishing Company Inc, Westport, & USA (1977).
3. BRASIL, Resolução 266, de 22 de setembro de 2005, Agência Nacional de Vigilância Sanitária 2005.
4. M. C. A. Maia, A. P. G. L. K. Galvão, R. C. Della Modesta, N. Pereira Júnior, "Avaliação sensorial de sorvetes à base de xilitol", *Ciência e Tecnologia de Alimentos*, **28**, pp.146-151 (2008).
5. W. S. Arbuckle, *Ice Cream*, AVI Publishing Company Inc, Westport, USA (1986).
6. R. Warke, A. Kamat, M. Kamat, P. Thomas, "Incidence of pathogenic psychrotrophs in ice creams sold in some retail outlets in Mumbai, India", *Food Control,* **11**, pp.77-83 (2000).
7. E. J. Mann, "Ice cream part l", *Dairy Industry*, **53**, pp.13-14 (1988).
8. "Brazilian Association of Ice Cream", http://www.abis.com.br/noticias_2009_8.html (2009).
9. U. Kanbakan, A. H. Con, A. Ayar, "Determination of microbiological contamination sources during ice cream production in Denizli, Turkey", *Food Control,* **15**, pp. 463-470 (2004).
10. N. El-Sharef, K. S. Ghenghesh, Y. S. Abognah, S. O. Gnan, A. Rahouma, "Bacteriological quality of ice cream in Tripoly-Lybia", *Food Control*, **17**, pp.b637-641 (2006).
11. S. A. Ferrage, E. H. Marth, "Interactions between *Listeria monocytogenes* and other psychrotrophic bacteria in dairy foods. A review", *Food Australia,* **44**, pp. 281-286 (1992).
12. M. S. Adeil-Pietranera, P. Narvaiz, P. Horak, E. Kairiyama, "Irradiated icecreams for immunosuppressed patients", *Radiation Physics and Chemistry*, **66**, pp.357-365 (2003).
13. H. R. Bolin, C. C. Huxoll, "Control of minimally processed carrot (*Daucus carota*) surface discoloration caused by abrasion peeling", *Journal of Food Science*, **56**, pp.416-418 (1991).
14. M. C. Bourne, "Texture profile analysis", *Food Technology*, **32(7)**, pp.62-66 (1978).

15. K. H. Oliveira, *Comportamento reológico de diferentes tipos de sorvete*, Universidade Federal de Santa Catarina, Florianópolis, Brasil (2005).
16. F. M. Durso, *Fatores que afetam a vida de prateleira de sorvetes de massas artesanais*, Instituto Mauá de Tecnologia, São Caetano do Sul, Brasil (2012).
17. D. B. Aime, S. D. Arntfield, L. J. Malcolmson, D. Ryland, "Textural analysis of fat reduced vanilla ice cream products", *Food Research International*, **34 (2-3)**, pp. 237-246 (2001).